Future Groundwater Use in Ljubljana Field and Mura Valley (Slovenia)

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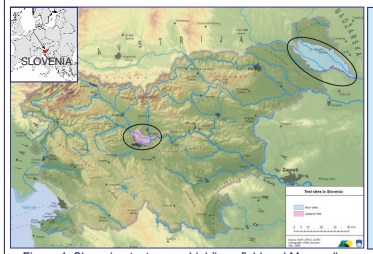
Introduction

Ljubljana field is a part of Ljubljana basin in the central part of the country (**Fig.1**). Mura valley, in the north eastern part of the country, belongs to Mura basin (**Fig.1**) Both are important "storages" of groundwater and main source of drinking water for more than 380.000 inhabitants. In an unconfined porous Ljubljana field aquifer the thickness exceeds 100 m, the groundwater is recharging from rainfall (50 %) and from the river Sava (50 %). The three quarters of the aquifer lie beneath the urbanized and agricultural area (**Fig.2**) The Mura valley porous aquifer is shallower, the average thickness is 17 m, the groundwater is recharging mainly from precipitation and most of the aquifer lies beneath the agricultural area (**Fig.3**).



There are three main water consumers on the test areas:

- households
- industry
- agriculture

Figure 1. Slovenian test areas; Ljubljana field and Mura valley

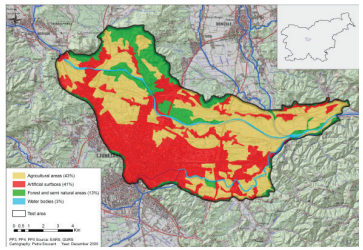


Figure 3. Ljubljana field – Land use after CLC 2006

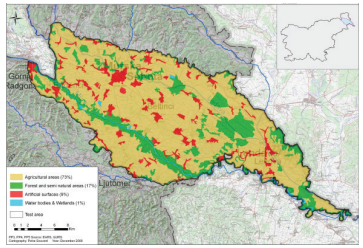


Figure 3. Mura valley – Land use after CLC 2006

CC-WaterS Project

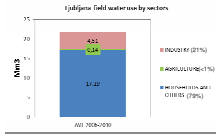
Ljubljana field and Mura valley were chosen as test areas in the project Climate Change and Impacts on Water Supply (CC-WaterS) . The aim of the project is to estimate the impact of climate change on drinking water supply in the Alpine region, middle and lower Danube and Adriatic sea coastal areas. In Slovenia two test areas were chosen because different land uses require different anthropogenic activities which modify the entire aquifer areas, impact the hydrological balance, reduce the aquifer recharge, influence the groundwater flow characteristics, change the water source availability and restoration and influence the quality of groundwater.

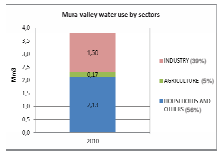
Groundwater Use

Present

Data sources for water use for households and industry is water works in Ljubljana field, located in Ljubljana and three major water works in Mura valley, located in Murska Sobota, Lendava and Ljutomer. Irrigation data (agriculture) are from water permits.

Test area	Consumption (L/capita/day)
Ljubljana field	150
Mura valley	109





Waterworks' water use trends for a given period in Mm3/year in Ljubljana field	Households and others	Industry	Sold together
1988-2010	-0,260	-0,217	-0,477
1999-2010	-0,160	-0,071	-0,231
2006-2010	-0,155	-0,073	-0,228

Waterworks' water use trends for a given period in Mm3/year in Mura valley	Households and others	Industry	Sold together
Mura valley (2004-2007)	**+0,051**	**-0,022**	**+0,031**
Murska Sobota (1999-2007)	-0,002	-0,138	-0,136
Lendava (2004-2010)	+0,011	-0,006	+0,005
Ljutomer (2002-2009)	/	/	-0,005

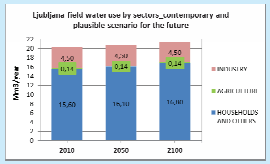
Future

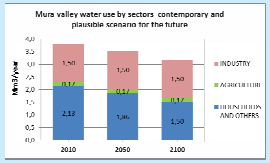
For the future groundwater use, three water uptake scenarios were made for the periods 2021-2050 and 2071-2100: optimistic (minimum water uptake-MIN), pessimistic (maximum water uptake-MAX) and moderate or plausible scenarios. They were made for each of the three different water consumers: households (people), industry and irrigation (agriculture).

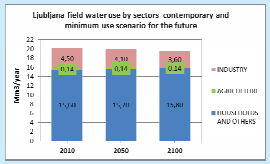
Available water resources vs. water use - plausible scenario

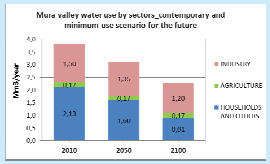
Total GW recharge and water use in Mm³/year (Ljubljana field)	1971-2000	2021-2050	2071-2100
ALADIN	78	73	48
RegCM3	72	73	75
Water use	**20,2**	**20,7**	**21,4**

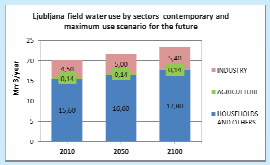
Total GW recharge and water use in Mm³/year (Mura valley)	1971-2000	2021-2050	2071-2100
ALADIN	78	73	48
RegCM3	72	73	75
Water use	**3,8**	**3,5**	**3,2**

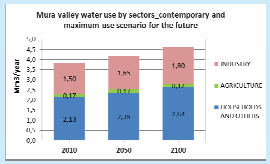






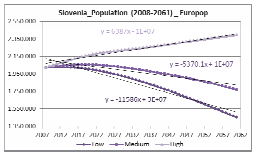






Discussion

Main water users in both test areas are households, industry and in smaller scale agriculture (irrigation). The water use in households depends on number of people living in the test areas, so the trends of population change



were taken from the Europop poll trends for Slovenia (2008-2061) and were modified with the expert judgment since there are no other scenarios available for the areas. It is assumed that in Mura valley, the population will decrease after plausible scenario but increase in Ljubljana field (with Ljubljana-the capital of Slovenia), since the trend in EU is migration to larger cities. The industrial water use for both test areas in the future were determined after present trends, which show decreasing industry water demand since mid eighties.

Industrial water use - Ljubljana field			
[Mm3]	MIN	MAX	PLAU.
2010		4,515	
change (%)	-10	+10	**0**
2050	4,1	5,0	**4,5**
change (%)	-20	+20	**0**
2100	3,6	5,4	**4,5**

Industrial water use - Mura valley			
[Mm3]	MIN	MAX	PLAU.
2007		1,5	
Change (%)	-10	+10	**0**
2050	1,35	1,65	**1,5**
Change (%)	-20	+20	**0**
2100	1,2	1,8	**1,5**

A 3 year crop rotation: maize - winter wheat - oil pumpkins was considered for Mura valley and maize-winter wheat - brassicas for Ljubljana field. It was estimated that the possible climate change would not initiate a change in crop rotation, so the water use for irrigation will remain the same.

Conclusions

It is expected that the water use in Mura valley will decrease after the most plausible scenario, because of diminishing trend of household's water use due to emigration. In Ljubljana field, the scenario is contrary. The water use will increase, because of a higher use of water for households (immigration). The water use for industry and agriculture will most likely remain the same for both test areas.

Aknowledgement

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